

US008773862B1

(12) **United States Patent**  
**Ullman**

(10) **Patent No.:** **US 8,773,862 B1**  
(45) **Date of Patent:** **Jul. 8, 2014**

(54) **HIGH-DEFINITION MULTIMEDIA INTERFACE TAP DEVICE**

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(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 214 days.

(21) Appl. No.: **13/555,513**

(22) Filed: **Jul. 23, 2012**

**Related U.S. Application Data**

(60) Provisional application No. 61/510,379, filed on Jul. 21, 2011.

(51) **Int. Cl.**  
**H05K 7/00** (2006.01)

(52) **U.S. Cl.**  
USPC ..... **361/728**; 361/825; 361/826

(58) **Field of Classification Search**  
USPC ..... 361/728-730, 752, 796, 800, 825, 826, 361/622, 644; 439/210, 428, 578, 424  
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,025,150	A *	5/1977	Nordberg et al. ....	439/218
4,307,435	A	12/1981	Ullman	
4,569,567	A *	2/1986	Zucchini .....	439/639
4,962,447	A *	10/1990	Ullman .....	361/814
6,119,401	A *	9/2000	Lin et al. ....	49/361
7,396,234	B2 *	7/2008	Sun .....	439/32
2010/0246647	A1	9/2010	Maillard et al.	

\* cited by examiner

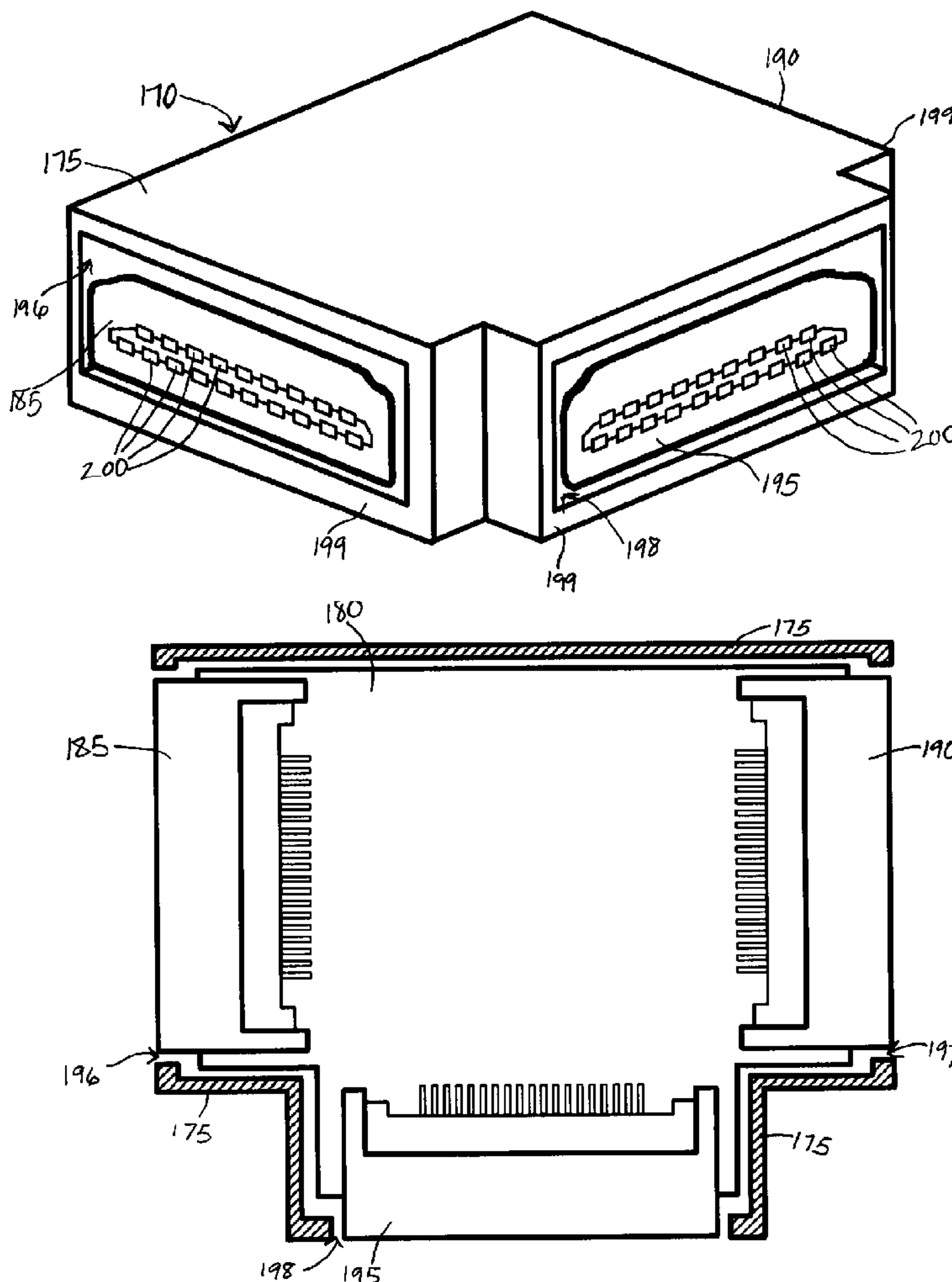
*Primary Examiner* — Hung S Bui

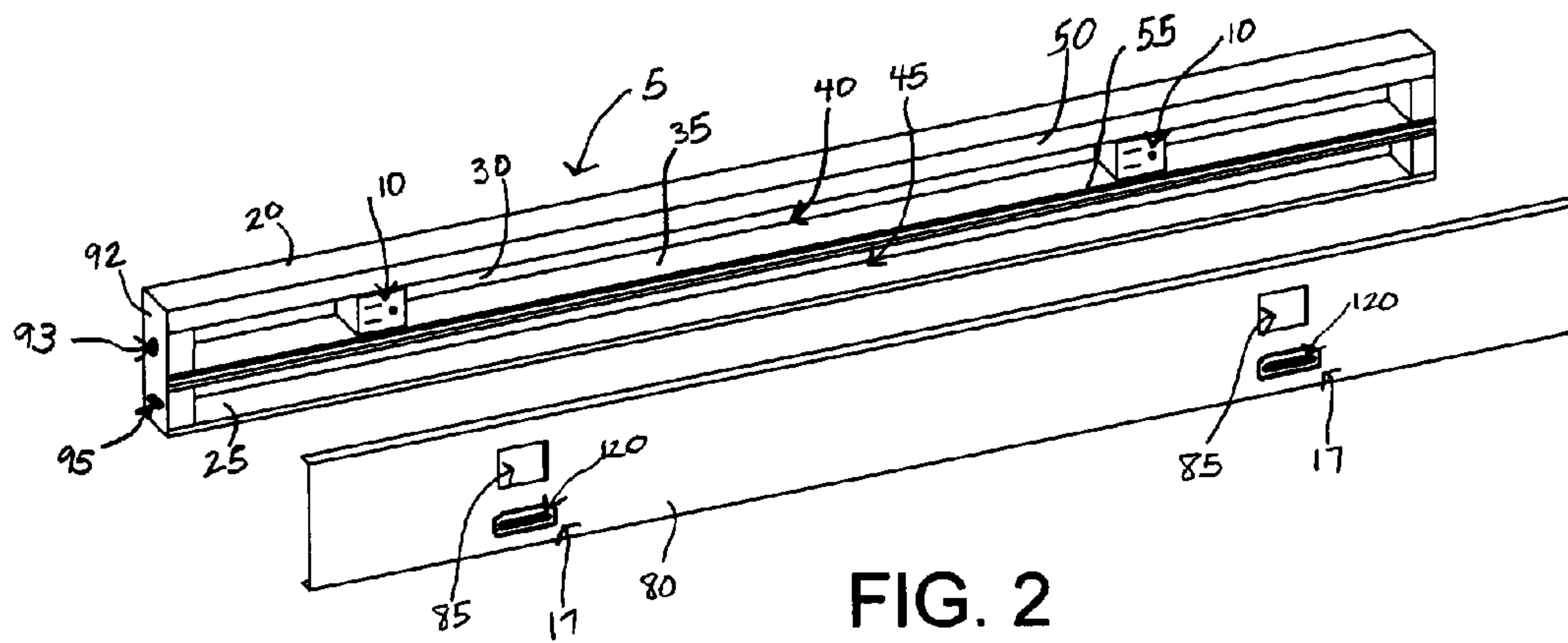
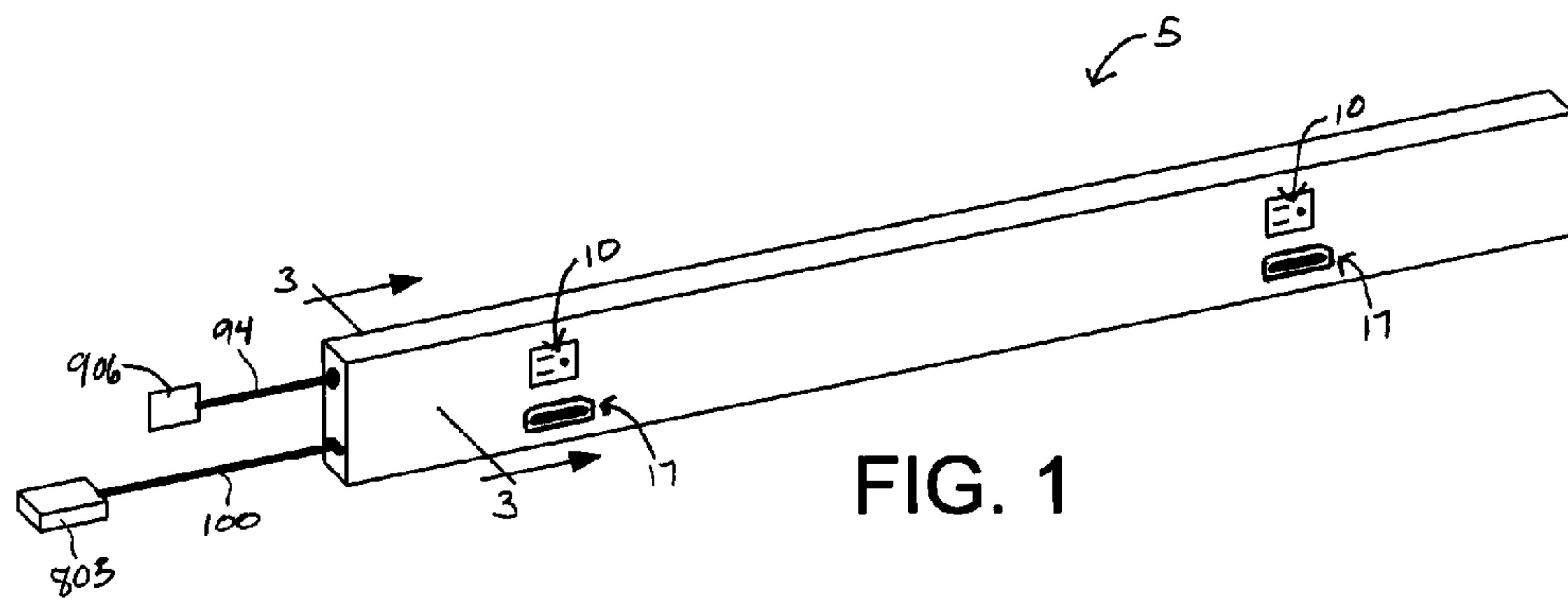
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(57) **ABSTRACT**

Preferred embodiments of a radio-frequency and electrical power distribution duct are implemented with high-definition multimedia interface HDMI receptacles to deliver high-bandwidth digital signals to multiple signal receivers.

**5 Claims, 8 Drawing Sheets**





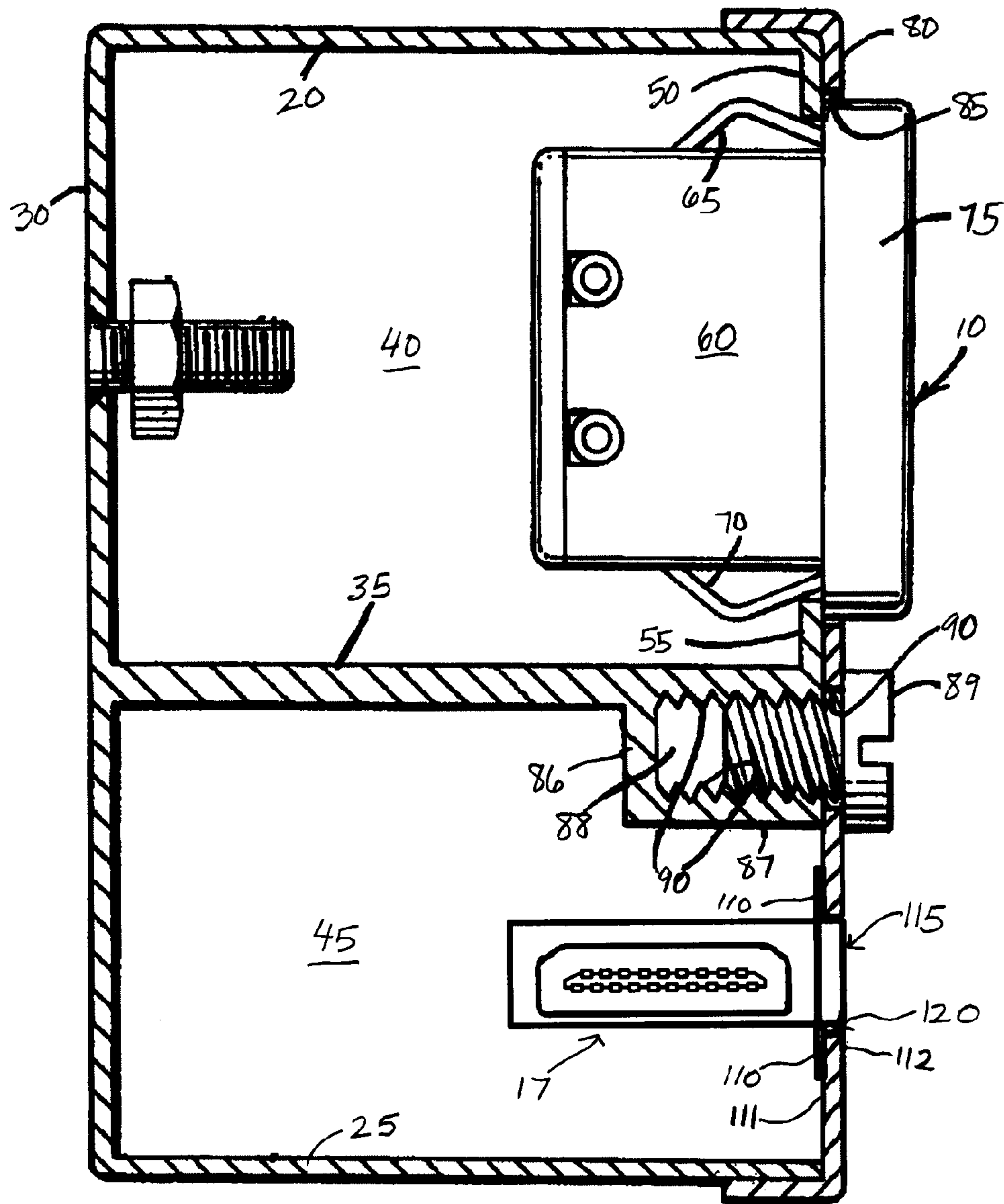


FIG. 3

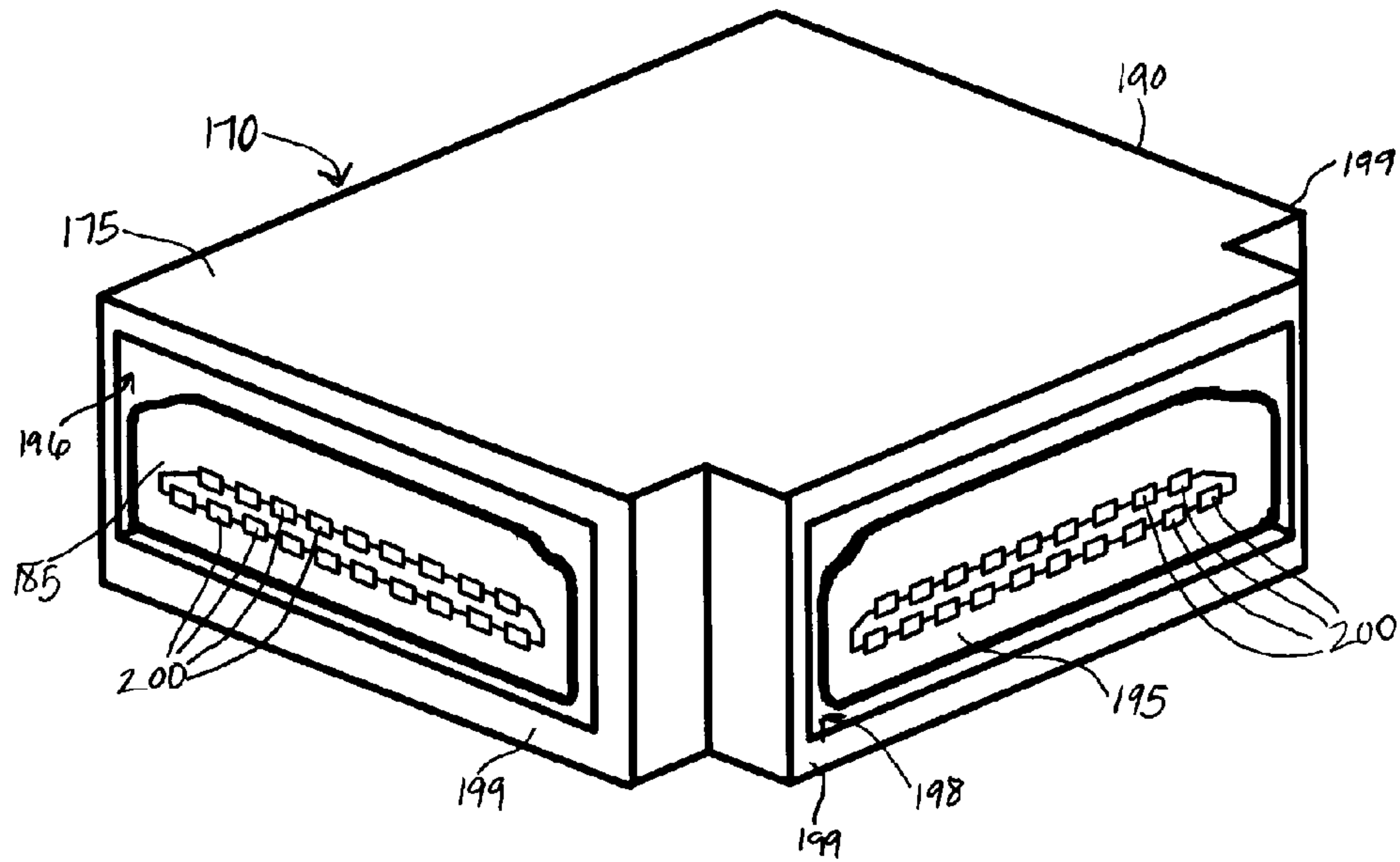


FIG. 4

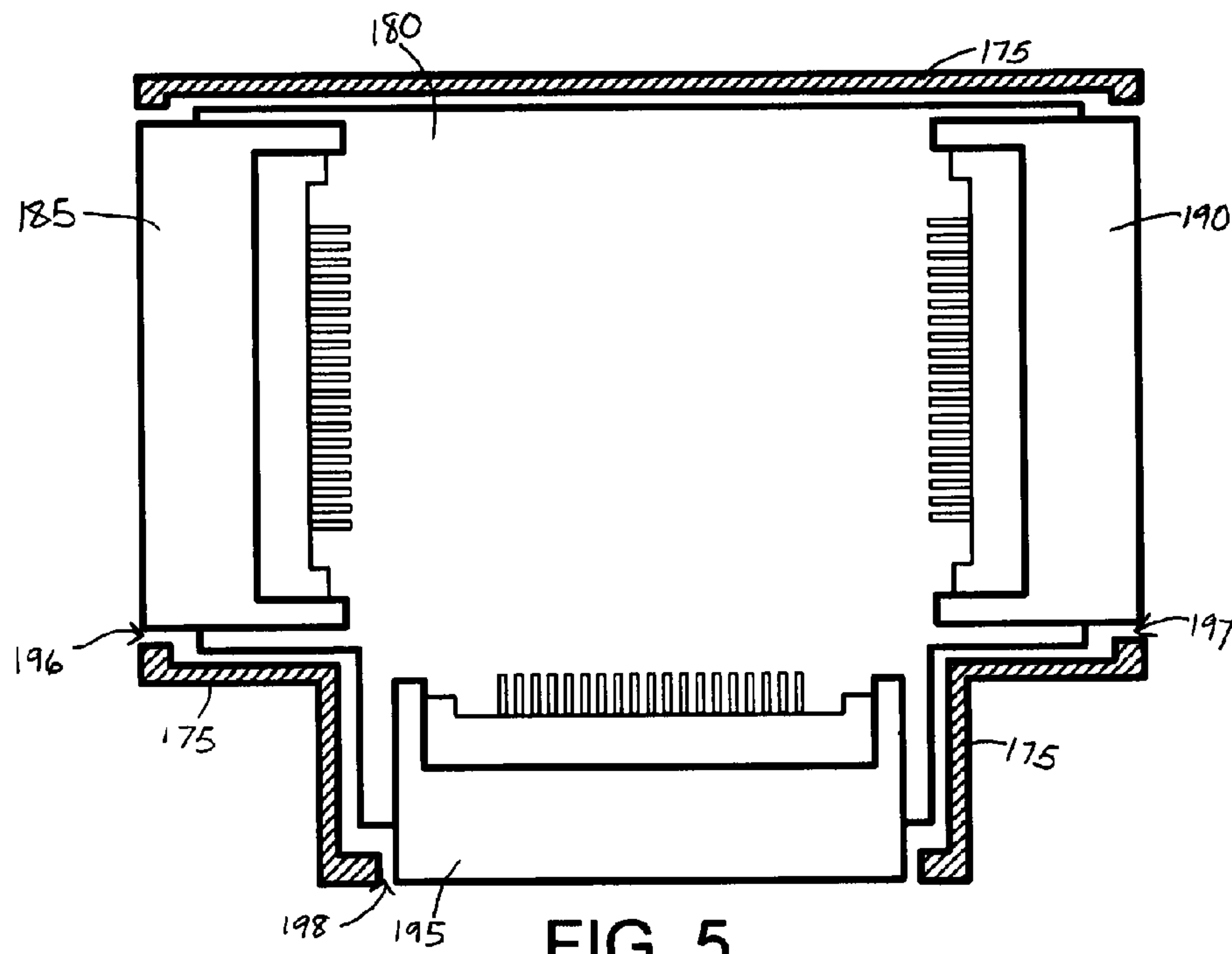


FIG. 5

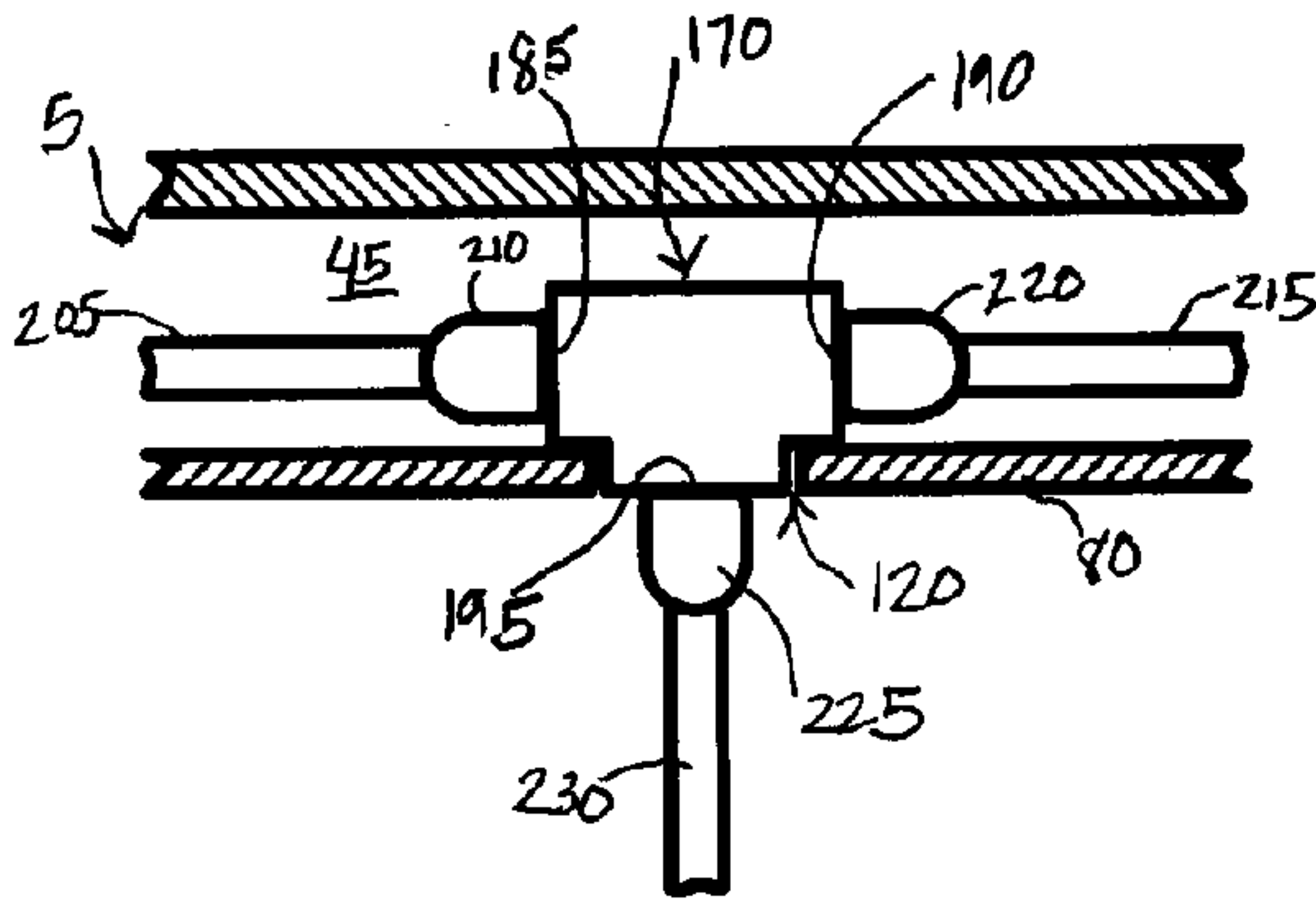


FIG. 6

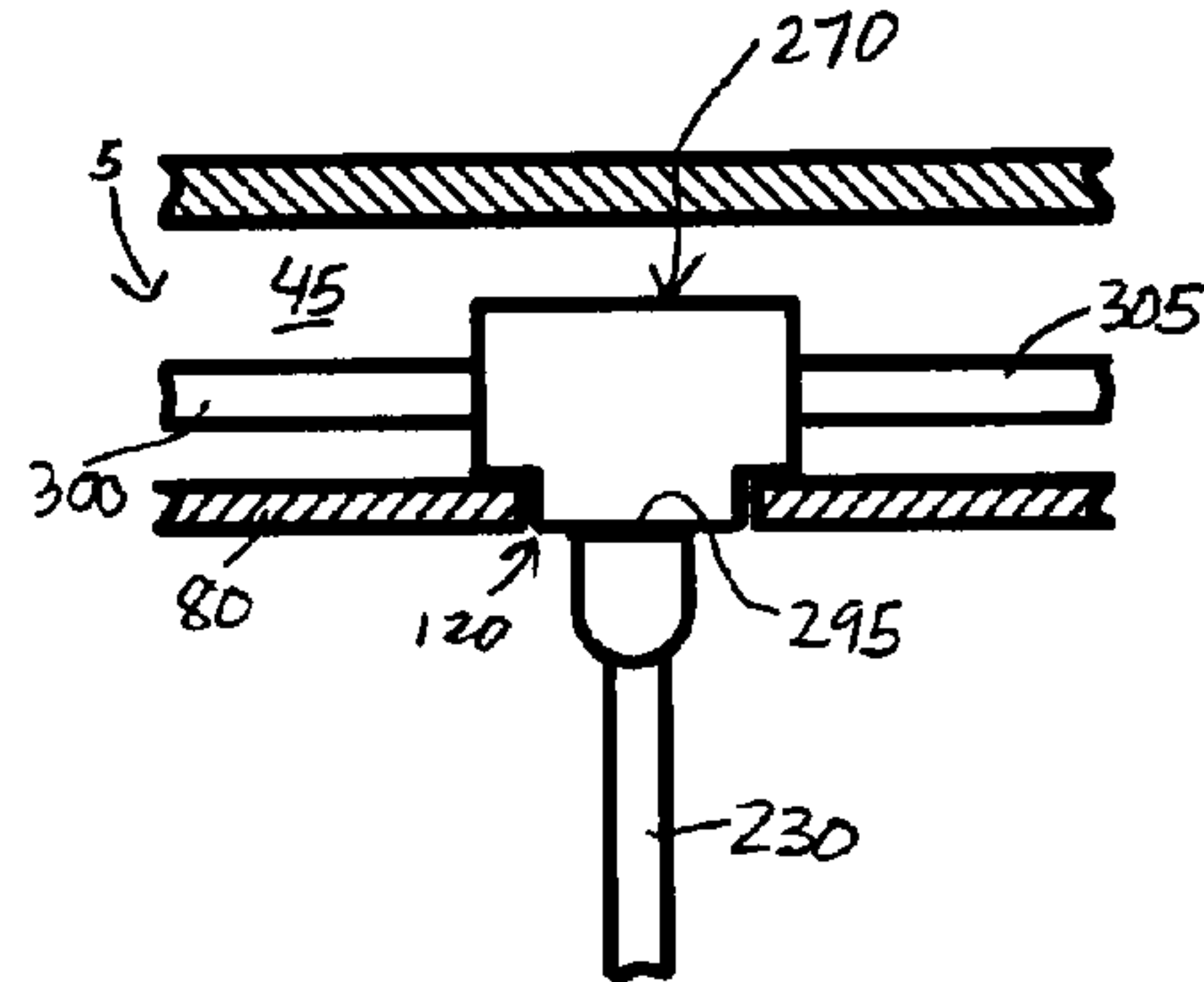


FIG. 7

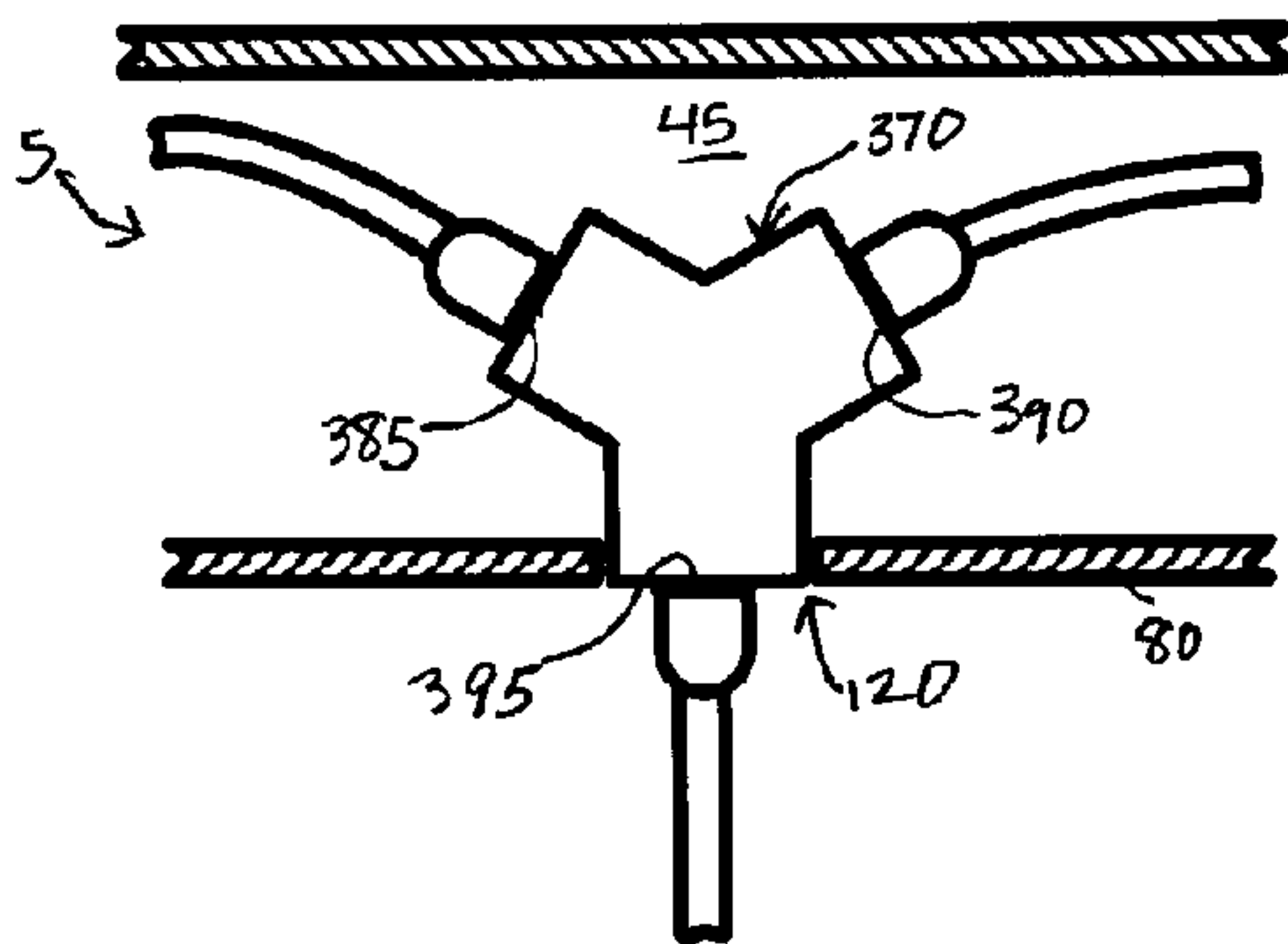


FIG. 8

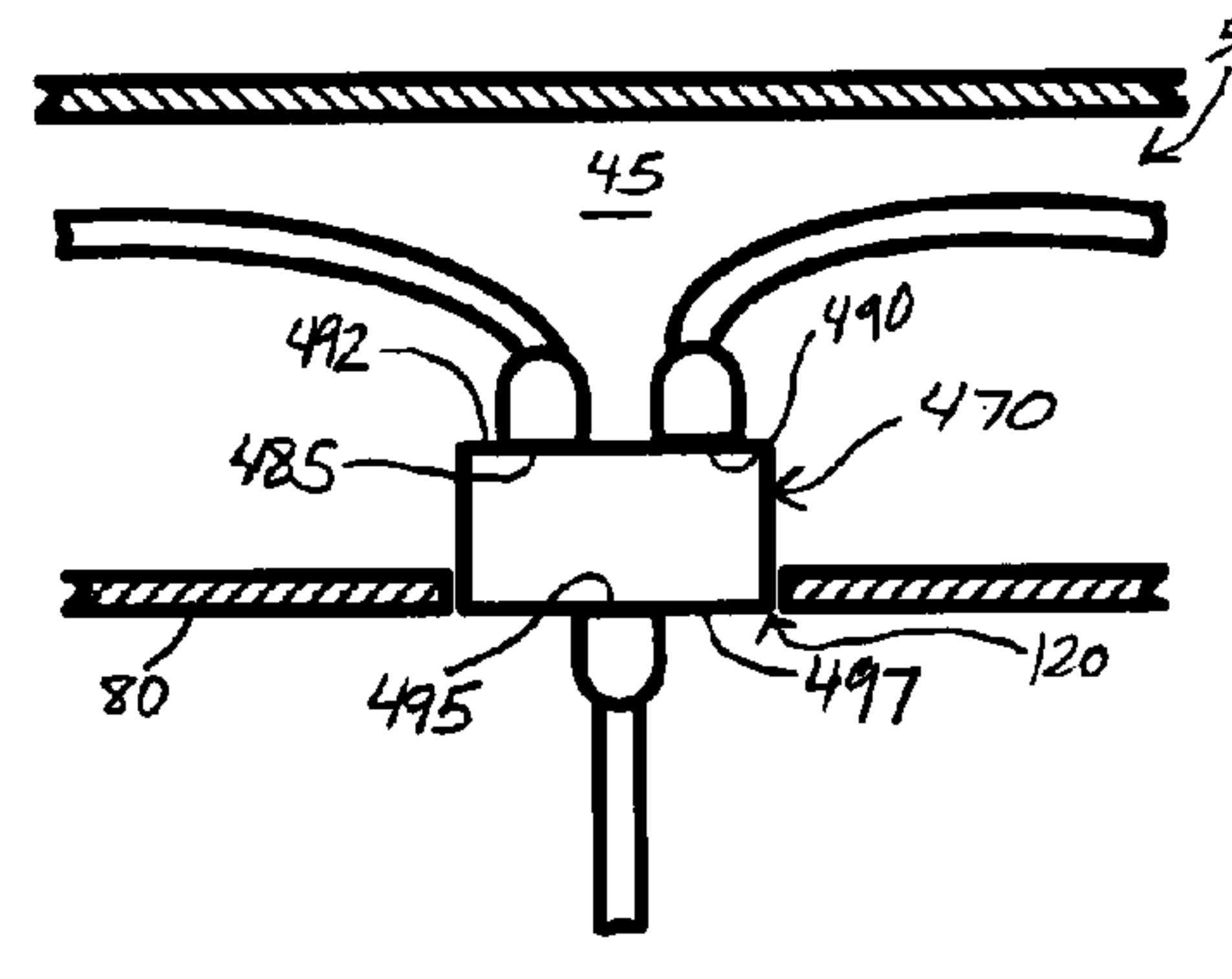


FIG. 9

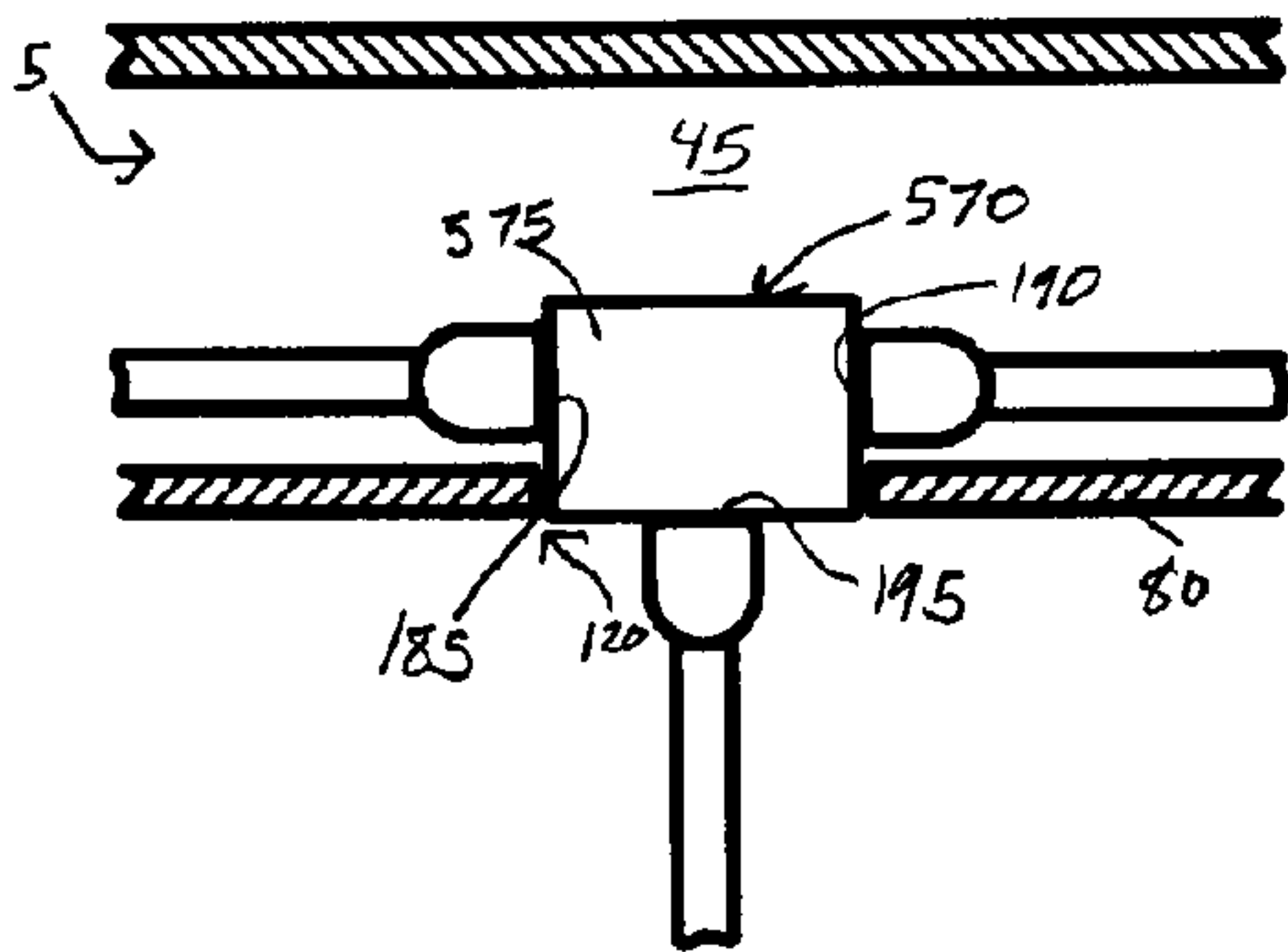


FIG. 10

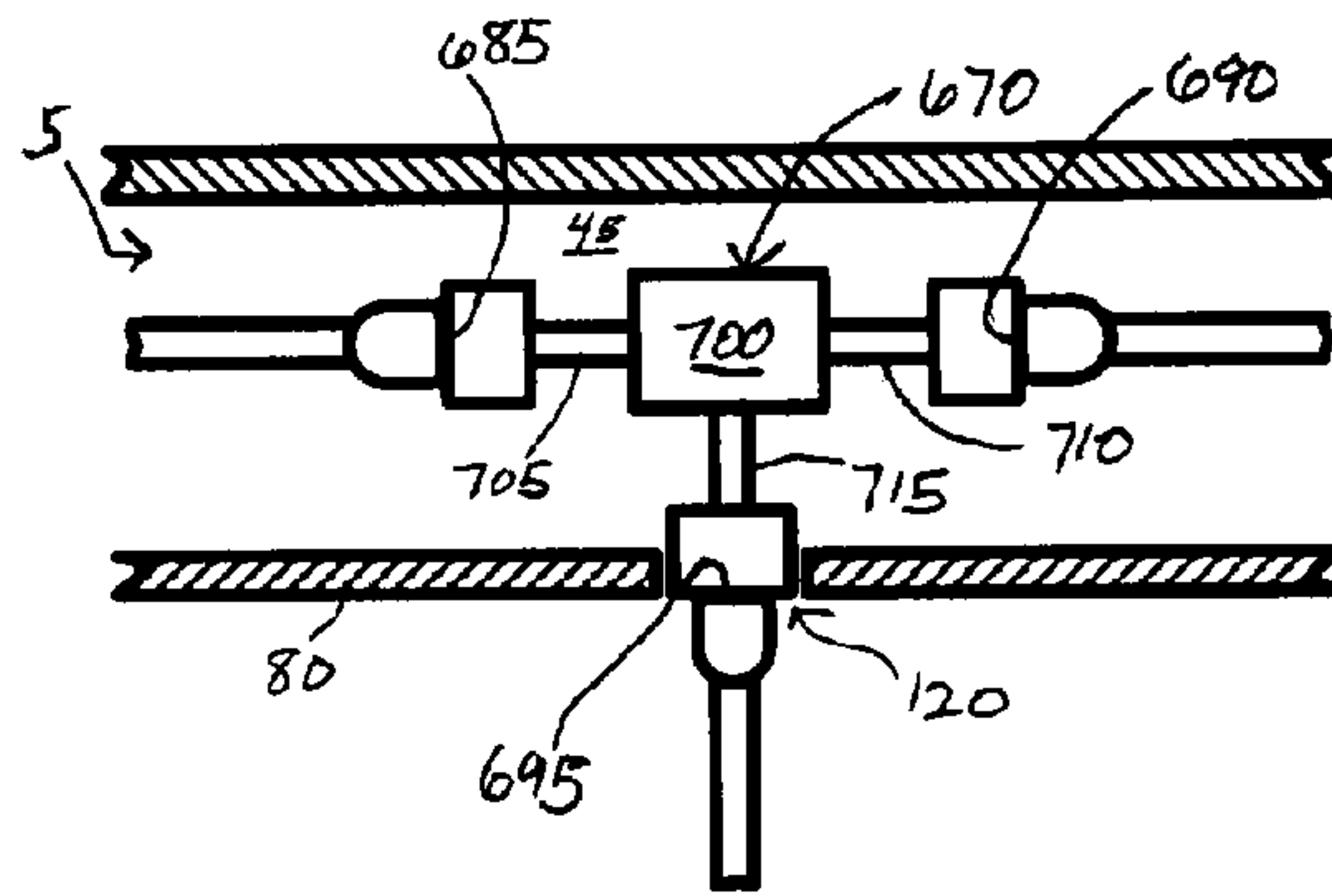


FIG. 11



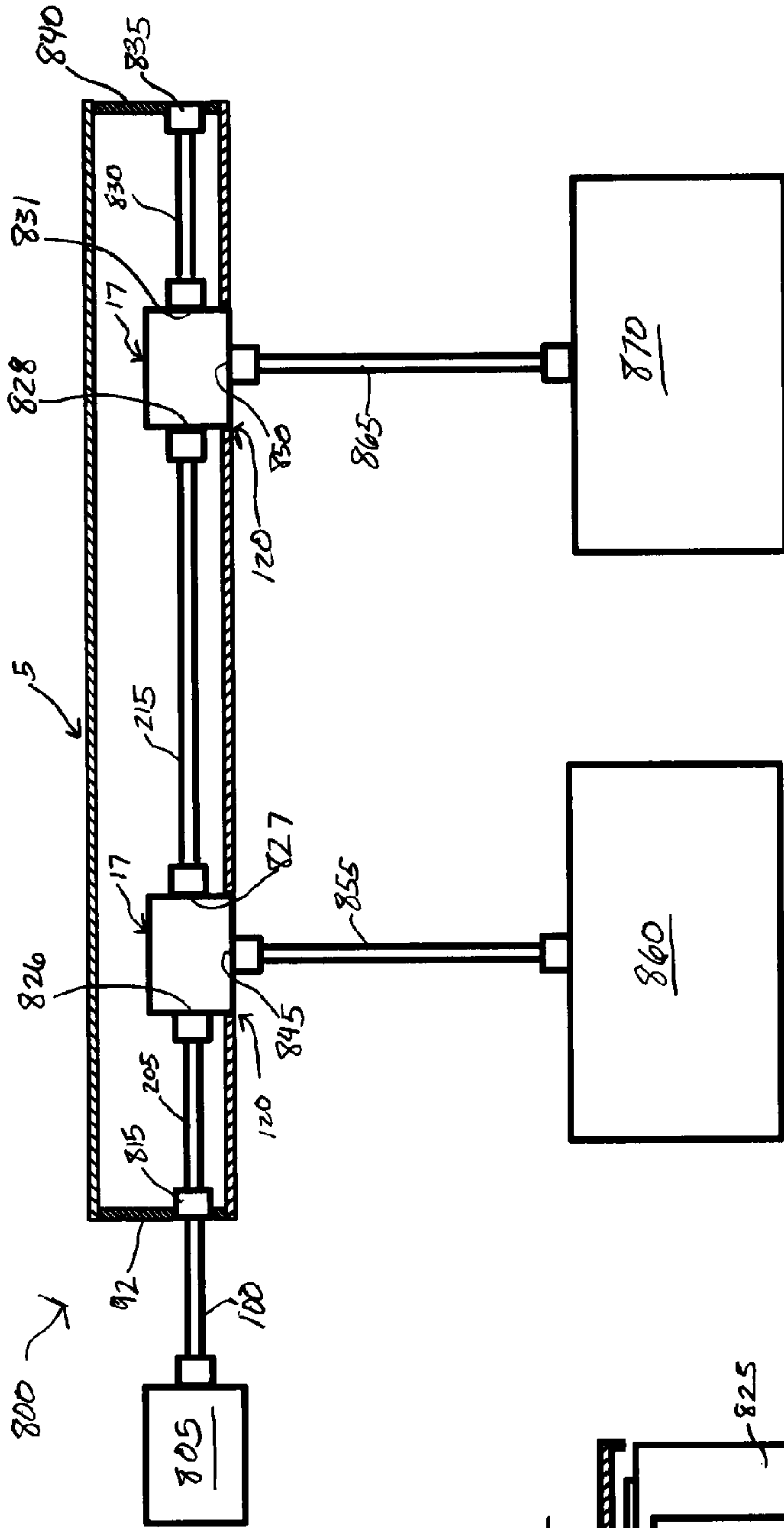


FIG. 12

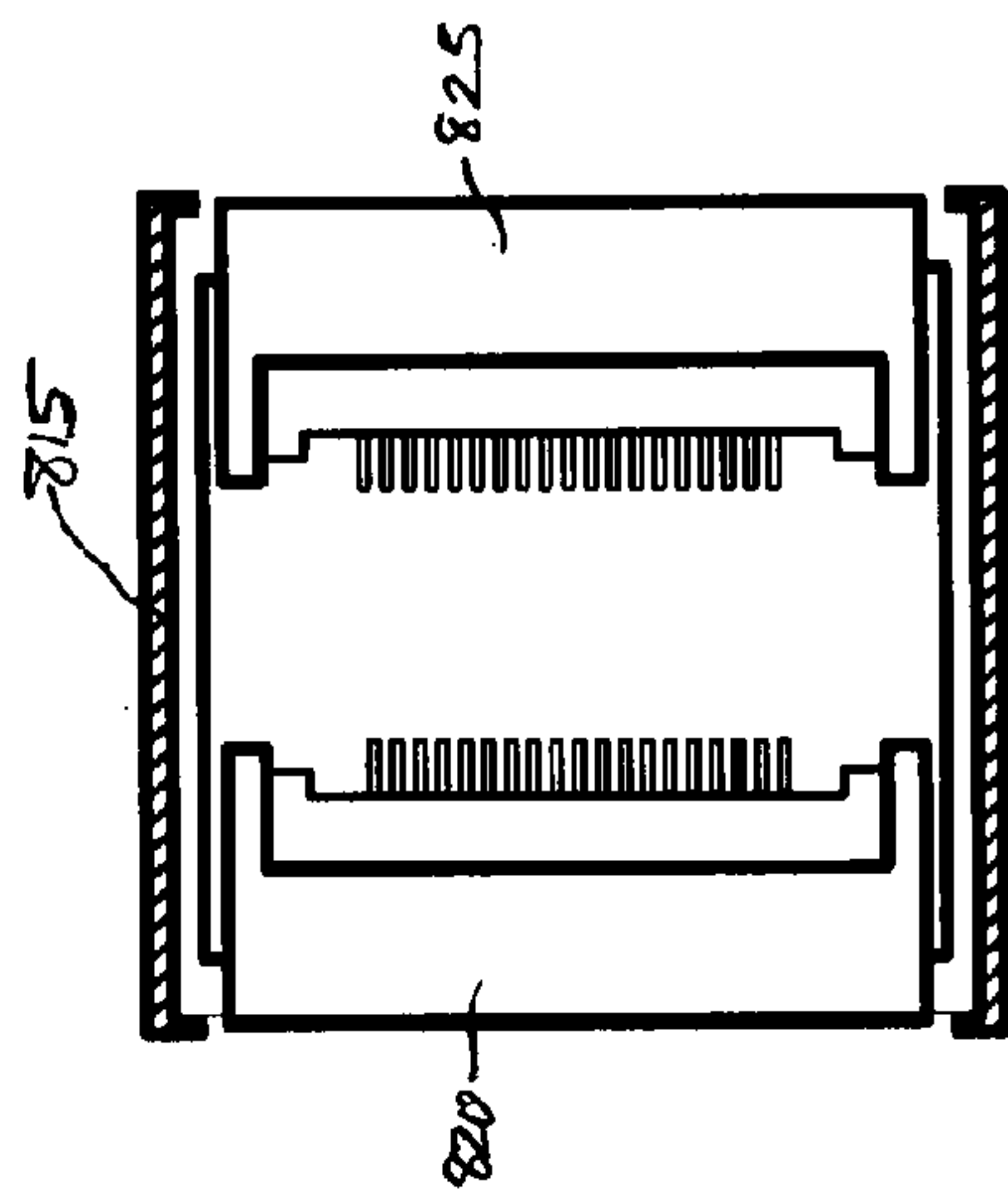


FIG. 13

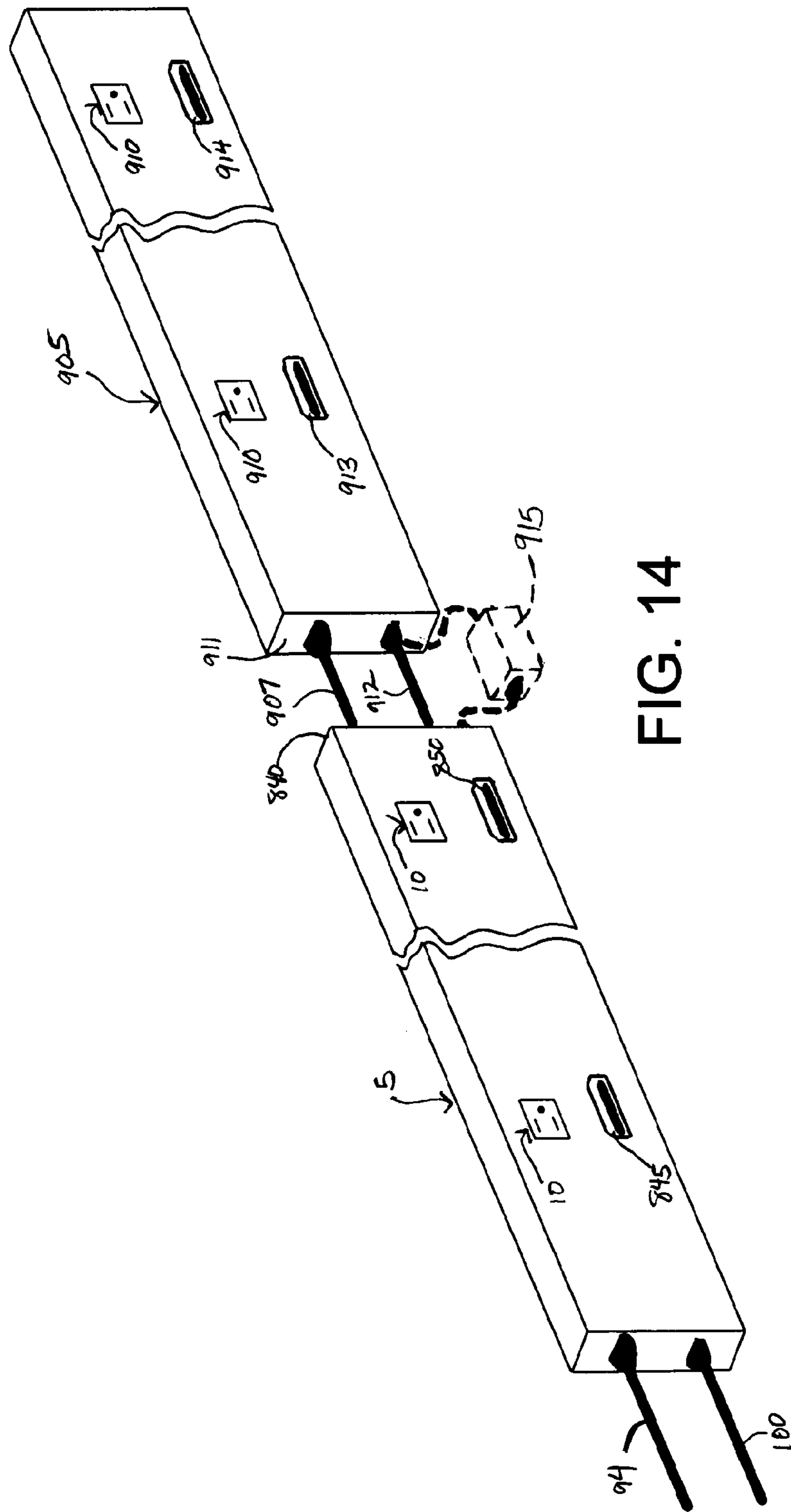


FIG. 14

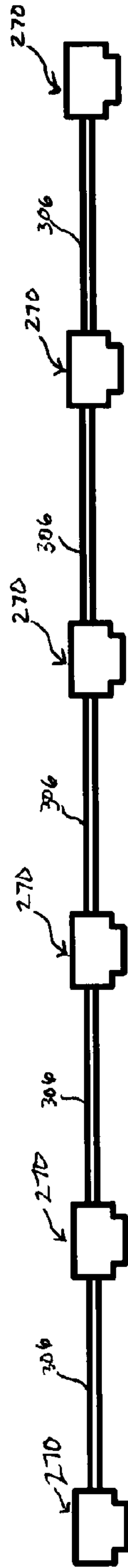


FIG. 15

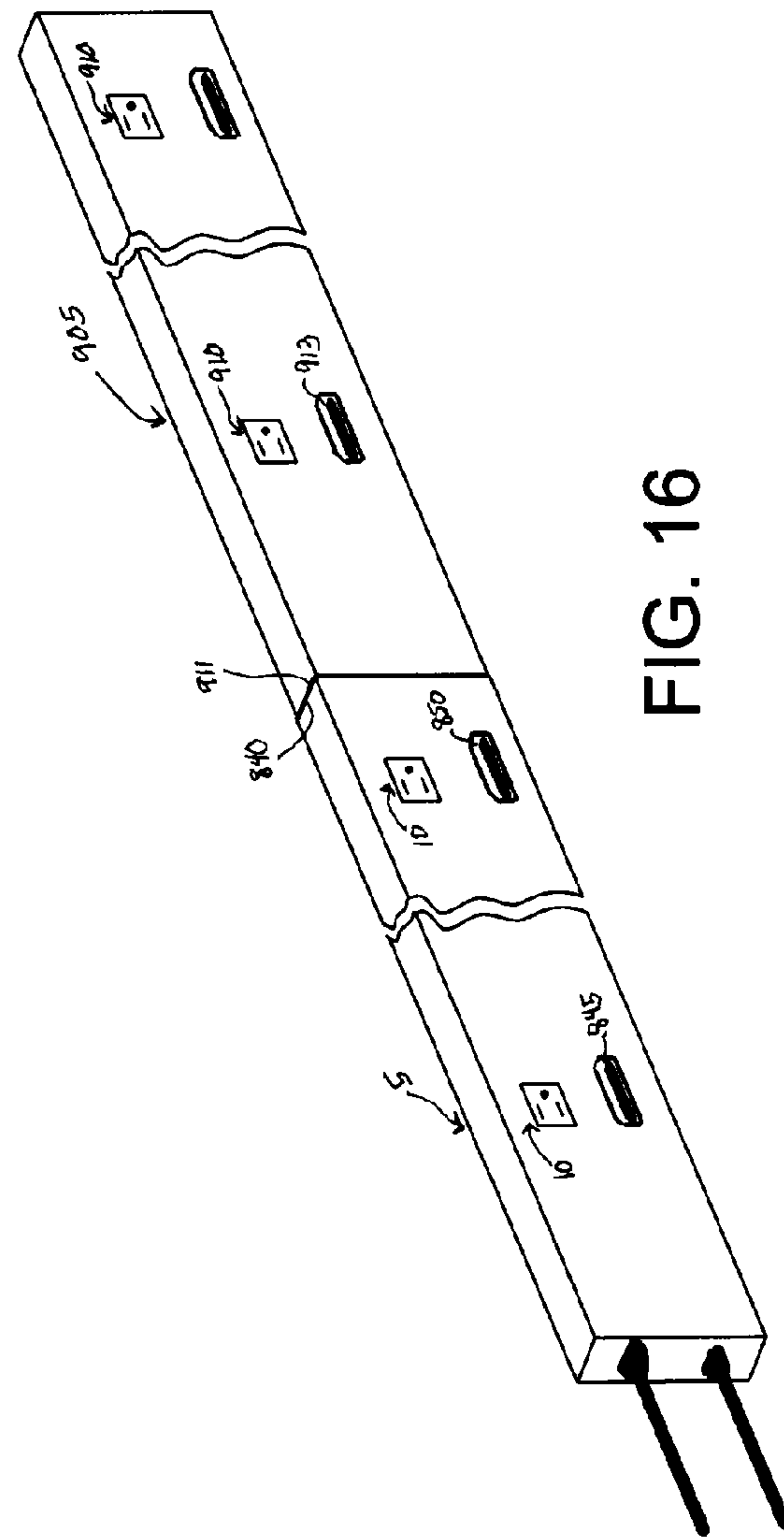


FIG. 16



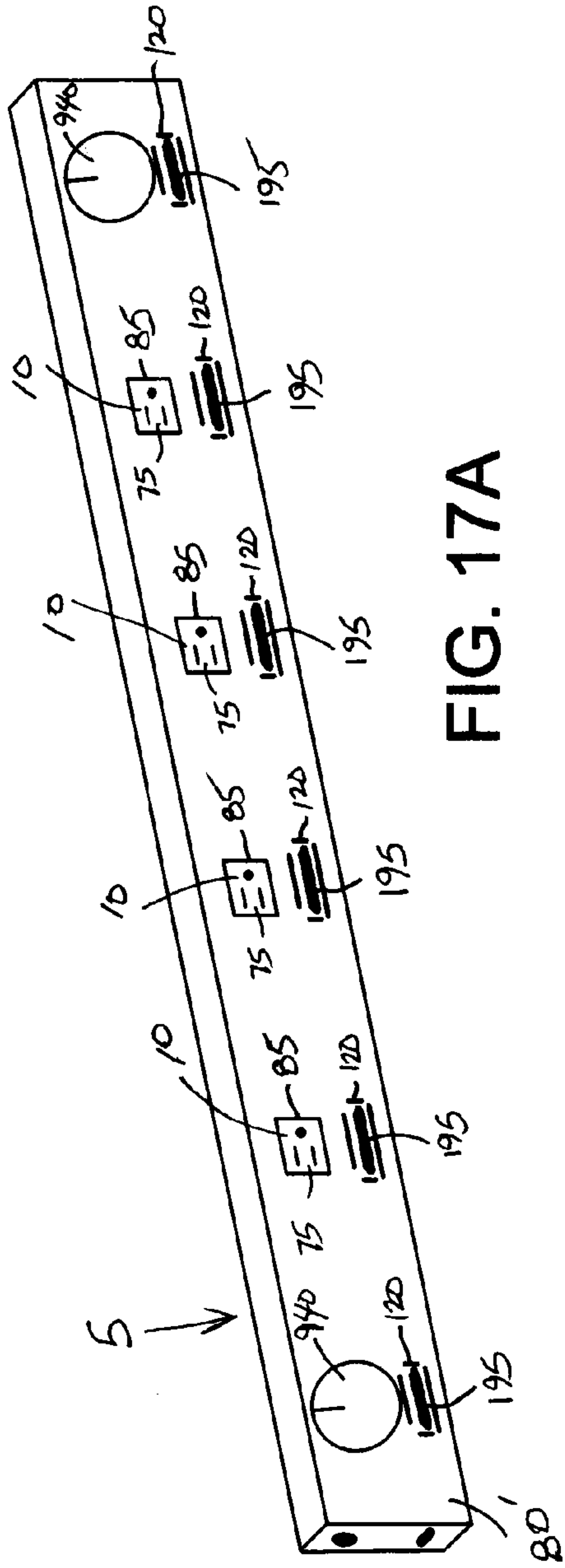


FIG. 17A

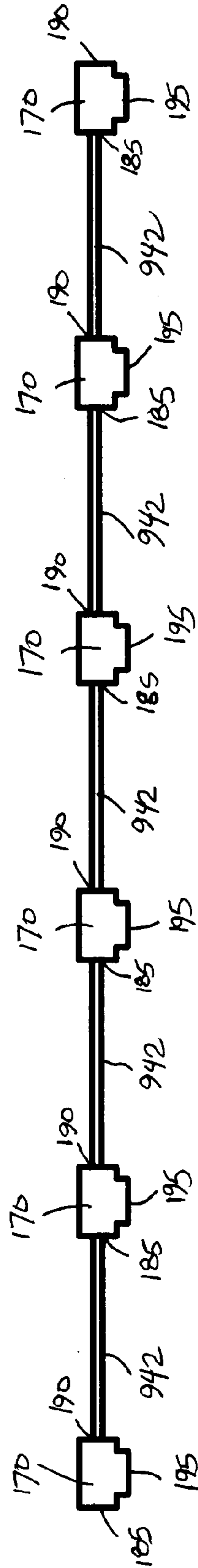


FIG. 17B

**1****HIGH-DEFINITION MULTIMEDIA  
INTERFACE TAP DEVICE**

## RELATED APPLICATION

This application claims benefit of U.S. Patent Application No. 61/510,379, filed Jul. 21, 2011.

## TECHNICAL FIELD

The field of this disclosure relates to digital signal delivery systems, and, in particular, to a system for delivering a digital signal to multiple output devices such as television sets (e.g., high-definition television sets).

## BACKGROUND INFORMATION

U.S. Pat. Nos. 4,307,435 and 4,962,447 describe radio-frequency and power distribution ducts to deliver signals and power to a plurality of receivers (e.g., television sets). A distribution duct includes longitudinal compartments containing power receptacles and radio-frequency signal receptacles. Specifically, the radio-frequency signal receptacles correspond to coaxial tees. One threaded shank of each coaxial tee extends through a hole in a cover of the distribution duct, and coaxial cables are connected to the two other threaded shanks of the coaxial tees to electrically connect them together to form a signal distribution system. The signal distribution system is connected to a source (e.g., an antenna) that supplies a signal to the system, and receivers are connected to the threaded shanks extending through the holes of the cover to deliver the signal to the receivers. One particularly useful application of these distribution ducts is the retail sale of television sets in which the television sets are connected to a single signal source and placed side-by-side to be viewed by customers.

Digital signal sources (e.g., digital signal broadcasters, digital versatile disc (DVD) players, Blu-ray disc players, digital set-top boxes) and digital receivers (e.g., high-definition television sets) have become increasingly popular over the last several years. Digital signal sources and digital receivers often include high-definition multimedia interface (HDMI) receptacles that facilitate communication of high-bandwidth digital signals representing one or both of high-quality video and high-quality audio. The applicant has recognized a need for a digital signal distribution system for delivering a high-bandwidth digital signal to multiple digital receivers.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an isometric view of a digital signal and power distribution duct according to one embodiment.

FIG. 2 is a partly exploded isometric view of the digital signal and power distribution duct of FIG. 1.

FIG. 3 is an enlarged sectional view of the digital signal and power distribution duct taken along the lines 3-3 of FIG. 1.

FIG. 4 is an isometric view of an HDMI tap device, according to one embodiment, used in the digital signal and power distribution duct of FIG. 1.

FIG. 5 is a sectional top view of the HDMI tap device of FIG. 4.

FIG. 6 is a fragmentary sectional top view of the digital signal and power distribution duct of FIG. 1 showing the HDMI tap device of FIG. 4 provided in a compartment of the duct and connected to signal lines.

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FIGS. 7-11 are fragmentary sectional top views of the digital signal and power distribution duct of FIG. 1 showing alternative HDMI tap device configurations.

FIG. 12 is a sectional top view of the digital signal and power distribution duct of FIG. 1 shown in relation to a digital signal distribution system that includes two HDMI tap devices in a daisy chain configuration.

FIG. 13 is a sectional top view of an HDMI coupler, according to one embodiment, used in the digital signal distribution system of FIG. 12.

FIG. 14 is an isometric view of two of the digital signal and power distribution ducts of FIG. 1 daisy chained together.

FIG. 15 is a top plan view of multiple HDMI tap devices hard-wired together to form a daisy chain.

FIG. 16 is an isometric view of two digital signal and power distribution ducts of FIG. 1 that abut each other and are connected together.

FIG. 17A is an isometric view showing the cover of a distribution duct that holds four power receptacles and six HDMI tap devices.

FIG. 17B is a diagram showing use of an extension printed circuit board to provide cableless electrical series interconnection of the six HDMI tap devices of FIG. 17A.

DETAILED DESCRIPTION OF PREFERRED  
EMBODIMENTS

FIG. 1 is an isometric view and FIG. 2 is a partly exploded isometric view of a digital signal and power distribution duct 5, according to one embodiment, for delivering power and digital signals to multiple digital output devices such as high-definition television sets. Duct 5 includes one or more power receptacles 10 and HDMI tap devices 17 (two power receptacles 10 and two HDMI tap devices 17 are shown in FIGS. 1 and 2) disposed between side walls 20, 25. In one non-limiting example, duct 5 is 8 feet in length and power receptacles 10 and HDMI tap devices 17 are provided every 12 or 16 inches along the length of duct 5. A bottom wall 30 joins side walls 20, 25 to form a generally U-shaped structure. A longitudinal partition 35 depends from bottom wall 30 to divide the U-shaped structure into a longitudinal power compartment 40 and a longitudinal digital signal compartment 45. Inwardly extending flanges 50, 55 extend from respective side walls 20, 25 toward longitudinal partition 35. Inwardly extending flanges 50, 55 support one or more power receptacles 10 as further explained with reference to FIG. 3.

FIG. 3 is a cross-sectional end view of duct 5. Each of the power receptacles 10 includes a body portion 60 having a width slightly less than a spacing between flanges 50, 55. Power receptacles 10 also include first and second outwardly extending spring members 65, 70 and an outer face 75 that has a width greater than the width of body portion 60 so that outer face 75 overlies the edges of flanges 50, 55. As power receptacles 10 are inserted into compartment 40, spring members 65, 70 compress to permit outer face 75 to seat against flanges 50, 55, and then spring members 65, 70 expand within compartment 40 to hold outer face 75 against flanges 50, 55.

Duct 5 includes a removable cover 80 that has longitudinally spaced-apart openings 85 that are sized to surround outer face 75 of power receptacles 10. Instead of power receptacles 10 having spring members 65, 70 to hold power receptacles 10 in duct 5, power receptacles 10 may be adhered to cover 80 using an adhesive or secured to it using rivets, screws, nuts and bolts or any other known fastener. Longitudinal partition 35 includes a depending bottom wall 86 and a side wall 87. Walls 86, 87, together with longitudinal partition 35, form a longitudinal channel 88 that has a width that is



appropriate to engage a suitable machine screw **89**. Optional serrations **90** may be formed in longitudinal partition **35** and wall **87** with a pitch matching that of the threads of screw **89**. Cover **80** includes a plurality of openings **90** to accommodate multiple machine screws, such as screw **89**. Rivets that engage longitudinal channel **88** may also be used to attach cover **80** to duct **5**.

Power receptacles **10** may be placed and moved anywhere along compartment **40**. Accordingly, the positions of power receptacles **10** may be adjusted to coincide with the locations of openings **85** in cover **80**. Power receptacles **10** are spatially aligned with openings **85** so that power receptacles **10** may be mated with power plugs of external power supply lines connected to output devices to thereby power the output devices. Power receptacles **10** are wired in parallel in a conventional manner prior to installation in compartment **40**. Conventional electrical conductors (e.g., power supply lines) for wiring the power receptacles **10** in parallel are not shown. Power receptacles **10** provide AC power connections for output devices. An end wall **92** of duct **5** includes a knock-out opening **93** to accommodate installation of a suitable power connector (e.g., power plug, power receptacle) or a power cord **94** that is hard-wired to one of receptacles **10**. Alternatively, knock-out opening **93** for the power connector or power cord **94** may be provided in cover **80**. Moreover, power cord **94** may be connected to a resettable fuse (not shown) positioned in power compartment **40**, and the resettable fuse may have a reset button that is accessible through an opening in cover **80**. End wall **92** also includes a second knock-out opening **95** to accommodate installation of an HDMI connector (e.g., HDMI receptacle connector) or an HDMI signal line **100** (e.g., HDMI cable) that is directly connected to one of HDMI tap devices **17**. Alternatively, knock-out opening **95** for the HDMI connector or HDMI signal line **100** may be provided in cover **80**.

FIG. **3** shows one of HDMI tap devices **17** provided in longitudinal digital signal compartment **45** and secured to cover **80**. HDMI tap devices **17** may be secured to cover **80** using any known securing mechanism and method including spring members similar to spring members **65**, **70** of power receptacles **10**. In one example, HDMI tap devices **17** includes flanges **110** that facilitate fastening of HDMI tap devices **17** to cover **80**. For example, flanges **110** may be adhered to cover **80** using an adhesive or secured to it using rivets, screws, nuts and bolts or any other known fastener. Flanges **110** may be secured to an inner face **111** of cover **80**, as shown in FIG. **3**, or an outer face **112** of cover **80**. Each of HDMI tap devices **17** includes a tap receptacle output face **115** that faces cover **80** and is spatially aligned with one of multiple longitudinally spaced-apart openings **120** in cover **80** to facilitate access to HDMI tap device **17**. Tap output receptacle output face **115** may sit flush with outer face **112** of cover **80** as shown in FIG. **3**. Alternatively, tap output receptacle output face **115** may extend outward beyond outer face **112** of cover **80** or may be recessed inward from outer face **112**.

HDMI tap devices **17** may be configured in various ways. In general, HDMI tap devices **17** include an input and at least two outputs, one of which is a tap output receptacle (i.e., female) connector configured to receive a plug of a standard HDMI signal line that is located external from compartment **45**. FIG. **4** is an isometric view of an HDMI tap device **170**, according to one embodiment. HDMI tap device **170** includes a housing **175** that has a “T” shaped profile and contains a printed circuit board (PCB) **180** as shown in FIG. **5**. Three HDMI receptacle connectors **185**, **190**, **195** are mounted on PCB **180** to form an in-line T-tap configuration for HDMI tap

device **170**. Specifically, connectors **185**, **190** face in opposite directions along a common axis (i.e., connectors **185**, **190** are in-line), and connector **195** faces in a direction that is transverse to the directions in which connectors **185**, **190** face to form a “T” shaped HDMI connector configuration. Connectors **185**, **190**, **195** are aligned with three openings **196**, **197**, **198** provided along side walls **199** of housing **175**. The in-line T-tap configuration of HDMI tap device **170** enables connector **195** to face and be spatially aligned with one of openings **120** in cover **80** of duct **5** and connectors **185**, **190** to face in directions along the longitudinal length of compartment **45** of duct **5** to thereby facilitate ease in connection of receptacle connectors **185**, **190** to plug connectors of HDMI cables in compartment **45**. In one example, connector **185** is an input receptacle connector, connector **190** is an output receptacle connector, and connector **195** is a tap output receptacle connector.

As shown in FIG. **4**, connectors **185**, **190**, **195** include pins **200** configured in a standard HDMI pin layout (e.g., connector type A layout, connector type B layout, connector type C layout). Pins **200** of connectors **185**, **190**, **195** are electrically connected to signal traces of PCB **180**. Moreover, the signal traces of PCB **180** are configured to electrically connect pins **200** of connector **185** to pins **200** of connectors **190**, **195** to form a digital signal tap in which a signal transmitted to connector **185** is further transmitted to connectors **190**, **195**.

FIG. **6** is a fragmentary sectional top view of duct **5** showing HDMI tap device **170** provided in compartment **45**. An input signal line **205** runs along compartment **45** and includes a plug **210** that mates with connector **185**, which serves as an input receptacle connector. An output signal line **215** also runs along compartment **45** and includes a plug **220** that mates with connector **190**, which serves as an output receptacle connector. Connector **195**, which serves as a tap output receptacle connector, is aligned with one of openings **120** in cover **80** and is mated with a plug **225** of a signal supply line **230** that is external to duct **5**. Plugs **210**, **220**, **225** each include pins that spatially align with and electrically connect to pins **200** of receptacle connectors **185**, **190**, **195**. In the configuration shown in FIG. **6**, a digital signal is supplied from input signal line **205** to receptacle connector **185**, from receptacle connector **185** to receptacle connector **190**, and from receptacle connector **190** to output signal line **215**. The digital signal is also supplied from receptacle connector **185** to receptacle connector **195**, and from receptacle connector **195** to signal supply line **230**.

Skilled persons will recognize that the configuration of HDMI tap device **170** is one possible configuration for HDMI tap devices **17** and that other configurations are possible. For example, FIGS. **7-11** are partial cross-sectional top plan views of duct **5** showing various other possible configurations for HDMI tap devices **17**. Configurations other than those shown in FIGS. **7-11** are possible for HDMI tap device **17**. FIG. **7** shows an HDMI T-tap device **270** that has a “T” shaped profile similar to device **170**. However, instead of having three receptacle connectors like device **170**, device **270** includes one receptacle connector **295** that connects to signal supply line **230**. An input signal line **300** and an output signal line **305** are hard-wired to a PCB of device **270**, and input signal line **300** is electrically connected to output signal line **305** and receptacle connector **295**. Multiple devices **270** may be hard-wired together. For example, FIG. **15** shows six devices **270** hard-wired together via signal lines **306** to form a hard-wired HDMI tap device daisy chain.

FIG. **8** shows an HDMI Y-tap device **370** that has a “Y” shaped profile. Device **370** includes three receptacle connectors **385**, **390**, **395** that are the same as connectors **185**, **190**,



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195 of device 170. Alternatively, device 370 may be configured like device 270 in which connectors 385, 390 are replaced with input signal line 300 and output signal line 305 that are hard-wired to a PCB of device 370.

FIG. 9 shows an HDMI tap device 470 that includes an input receptacle connector 485 and an output receptacle connector 490 provided along one side wall 492 of device 470 and a tap output receptacle connector 495 provided along a second side wall 497 opposite side wall 492. Alternatively, device 470 may be configured like device 270 in which connectors 485, 490 are replaced with input signal line 300 and output signal line 305 that are hard-wired to a PCB of device 470.

FIG. 10 shows an HDMI T-tap device 570 that is identical to device 170 except that a housing 575 of device 570 has a rectangular shaped profile instead of a "T" shaped profile. Alternatively, device 570 may be configured like device 270 in which connectors 185, 190 are replaced with input signal line 300 and output signal line 305 that are hard-wired to a PCB of device 570.

FIG. 11 shows an HDMI T-tap device 670 that includes HDMI receptacle connectors 685, 690, 695 that are electrically connected to a central tap unit 700 via intermediary signal lines 705, 710, 715 that are hard-wired to connectors 685, 690, 695 and a PCB contained in central tap unit 700. Signal lines 705, 710, 715 may be flexible to enable connectors 685, 690, 695 to be maneuvered to various positions.

In some of the configurations of HDMI tap devices 17 in which HDMI tap devices include input and output receptacle connectors, the tap output receptacle connector is positioned to face a different direction from the direction(s) that the input and output receptacle connectors face. Accordingly, the input and output receptacle connectors of HDMI tap devices 17 may be conveniently and easily connected to signal lines contained in compartment 45 of duct 5, while only the tap output receptacle connectors of HDMI tap devices 17 are visible through openings 120 of cover 80. In other configurations of HDMI tap devices 17 in which HDMI tap devices 17 include hardwired input and output signal lines 300, 305, the tap output receptacle connector is positioned to face a different direction than the direction(s) along which input and output signal lines 300, 305 run.

FIG. 12 is a sectional top view of duct 5 shown in relation to a digital signal distribution system 800 that includes two HDMI tap devices 17 and other components. A digital signal source 805 (e.g., a digital signal media source) is connected to HDMI signal line 100. Signal line 100 is connected to an HDMI receptacle connector 815 that is positioned along end wall 92 of duct 5. In one embodiment, HDMI receptacle connector 815 is a receptacle coupler that includes two in-line receptacle connectors 820, 825, as shown in FIG. 13, that are electrically connected to each other. In this embodiment, a plug of signal line 100 is mated with one of receptacles 820, 825, and a plug of input signal line 205 is connected to the other one of receptacles 820, 825. In an alternative embodiment, connector 815 includes one receptacle that is connected to signal line 100, and input signal line 205 is hard-wired to connector 815. Alternatively, signal line 100 may pass through knock-out opening 95 in end wall 92 and be directly connected or hard-wired to a first one of HDMI tap devices 17. In another alternative embodiment, signal line 100 may pass through knock out opening 95 in end wall 92 and be connected or hard-wired to a signal amplifier (e.g., signal boosting device). In another alternative embodiment, signal line 100 may be a CAT 5, CAT 6, coax, fiber optic, or other type of cable and may connect to an adapter (e.g., an HDMI over CAT 5E/CAT6 receiver, HDMI over coax receiver,

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HDMI over fiber optic receiver) that configures (e.g., converts) the signal traveling along signal line 100 to an HDMI useable signal.

Input signal line 205 is connected to an input receptacle connector 826 of a first one of HDMI tap devices 17. Output signal line 215 is connected between an output receptacle connector 827 of the first one of HDMI tap devices 17 and an input receptacle connector 828 of a second one of HDMI tap devices 17 to electrically connect HDMI tap devices 17 together. Optionally, a signal line 830 may be connected between an output receptacle connector 831 of the second one of HDMI tap devices 17 and an HDMI receptacle connector 835 provided along a second end wall 840 of duct 5. HDMI receptacle connector 835 may be a receptacle coupler as shown in FIG. 13 or may be hard-wired to signal line 830 and include one receptacle that faces outward from second end wall 840. In an alternative embodiment, second end wall 840 does not include HDMI receptacle connector 835 and signal line 830 passes through a knock-out opening provided in second end wall 840.

Tap output receptacle connectors 845, 850 of HDMI tap devices 17 are aligned with and face one of openings 120 of cover 80. A signal supply line 855 is connected between tap output receptacle connector 845 and a digital output device 860, and a signal supply line 865 is connected between tap output receptacle connector 850 and a digital output device 870.

In operation, digital signal source 805 transmits a digital signal to the first one of HDMI tap devices 17 through signal line 100, connector 815 and input signal line 205. The first one of HDMI tap devices 17 supplies the digital signal to the second one of HDMI tap devices 17 through output signal line 215 and to output device 860 through supply line 855. The second one of HDMI tap devices 17 supplies the digital signal to output device 870. In this manner, both of output devices 860, 870 produce a representation of the digital signal (e.g., display images represented in the digital signal).

Duct 5 may be connected to other digital signal and power distribution ducts to increase the number of output devices connected to digital signal distribution system 800. FIG. 14 shows one embodiment in which duct 5 is electrically connected to a second duct 905. Power receptacles 10 of duct 5 receive electrical power from an external power source 906, shown in FIG. 1, via power cord 94. A power cord 907 is connected between duct 5 and duct 905 to deliver power to power receptacles 910 of duct 905. Power cord 907 may pass thorough knock-out openings in end walls 840, 911 of ducts 5, 905 and be hard-wired to power receptacles 10, 910, or end walls 840, 911 may include power connectors (e.g., power receptacles, power plugs) to which power cord 907 connects to enable easy connection and disconnection of power between ducts 5, 905. External power supply lines connected to output devices are electrically connected to power receptacles 10, 910 to thereby deliver power to the output devices.

Tap output receptacle connectors 845, 850 of duct 5 receive digital signals from digital signal source 805 via signal line 100. A signal line 912 is connected between duct 5 and duct 905 to deliver the digital signals to tap output receptacle connectors 913, 914 of duct 905. As described above, end wall 840 may include connector 835 to which signal line 912 connects. Alternatively, signal line 912 may pass through a knock-out opening in end wall 840 and be connected or hard-wired to the HDMI tap device that includes receptacle connector 850. End wall 911 of duct 905 may include an HDMI receptacle connector (e.g., a receptacle coupler as shown in FIG. 13) to which signal line 912 connects or a knock-out opening through which signal line 912 passes



through to connect to the HDMI tap device that includes tap output receptacle connector **913**.

In an alternative embodiment shown in FIG. **16**, ducts **5**, **905** may abut each other instead of having power cord **907** and signal line **912** provided between them. In this embodiment, power receptacles **10**, **910** may be hard-wired together and HDMI tap devices including tap output receptacle connectors **850**, **913** may be hard-wired together. Alternatively, ducts **5**, **905** may include matable (plug and receptacle) power connectors and matable (plug and receptacle) HDMI connectors provided along end walls **840**, **911**, and the matable power and HDMI connectors electrically connect together when ducts **5**, **905** abut each other.

Skilled persons will recognize that one or more other digital signal and power distribution ducts may be connected (e.g., daisy chained) to ducts **5**, **905**. In one embodiment, a signal boosting device **915** (e.g., an HDMI signal extender, a repeater), as shown in FIG. **14**, may be connected in series between ducts **5**, **905** to boost the digital signal supplied to the HDMI tap devices of duct **905**. Signal boosting device **915** enables the digital signal to maintain an acceptable signal level over a longer distance than a system without signal boosting device **915**. Accordingly, signal boosting device **915** may be used to increase the number of ducts daisy chained to duct **5**. In one embodiment, one or both of ducts **5**, **905** have an integrated signal boosting device provided in digital signal compartment **45** to boost the digital signal. An integrated signal boosting device may be used in the configuration shown in FIG. **16**, for example. In another embodiment, one or more of the signal lines (e.g., signal lines **100**, **205**, **215**, **830**, **855**, **865**, **912**) that supply the digital signal are active cables that include signal-enhancement electronics embedded in the housing of the signal lines that boost the digital signal.

The digital signal may be supplied over various types of cables that enable the digital signal to be transmitted a longer distance than the distance provided by a typical HDMI cable. For example, a CAT 5, CAT 6, coax, fiber optic, or other cable system may be used to transmit the signal to one or more HDMI tap devices **17**. For example, a transmitter (e.g., an extender) may be connected between an HDMI signal source and a CAT 5, CAT 6, coax, fiber optic, or other type of cable that enables an HDMI signal to be transmitted over the cable. A receiver is connected between the CAT 5, CAT 6, coax, fiber optic, or other type of cable and one or more HDMI tap devices **17** to condition the signal traveling along the cable for reception by HDMI tap devices **17**. The transmitter and receiver may incorporate boosters and equalization electronics to improve the quality of the digital signal. One or more of the transmitter and receiver may be incorporated in ducts **5**, **905** (e.g., provided in or on the housing of ducts **5**, **905**) or may be stand-alone units.

FIG. **17A** shows a cover **80'** for the U-shaped structure of distribution duct **5**. Cover **80'** has along its length (preferably about 4 ft. (1.22 m)) six spaced-apart square openings **85** and four spaced-apart rectangular openings **120**. Each square opening **85** is sized to surround outer face **75** of a power receptacle **10** placed in power compartment **40** (FIG. **2**). Each rectangular opening **120** receives tap output receptacle connector **195** of an HDMI tap device **170** placed in digital compartment **45** (FIG. **2**). Gain control knobs **940** are each connected to a signal boosting device **915** (FIG. **14**) installed in digital signal compartment **45** to provide for adjustable digital signal strength.

FIG. **17B** shows an embodiment in which HDMI output and input receptacle connectors **190**, **185** of next adjacent HDMI tap devices **170** are interconnected in electrical series

by an extension printed circuit board (PCB) **942**, thereby eliminating cable interconnections. Each extension PCB **942** has signal traces that, at their ends, terminate in HDMI receptacle connectors that are matable to their associated HDMI tap device connectors. Corresponding pins **200** (FIG. **4**) configured in standard HDMI layout of HDMI receptacle connectors **185**, **190** are electrically connected by associated signal traces of extension PCB **942**. FIG. **17B** shows that each left-side HDMI receptacle connector of PCB **942** is mated with an output receptacle connector **190** and each right-side HDMI receptacle connector of PCB **942** is mated with an input receptacle connector **185**. Input receptacle connector **185** of the left-most HDMI tap device **170** and output receptacle connector **190** of the right-most HDMI tap device **170** can be connected by coaxial cables to, respectively, receive input and deliver output digital signals.

It will be obvious to skilled persons that many changes may be made to the details of the above-described embodiments without departing from the underlying principles of the invention. The scope of the invention should, therefore, be determined only by the following claims.

The invention claimed is:

**1.** A high-definition multimedia interface tap device for use in a digital signal distribution duct configured to supply a digital signal to multiple output devices, the distribution duct including a cover having multiple longitudinally spaced-apart openings, comprising:

a housing containing a circuit board and including multiple openings;

an input receptacle connector connected to the circuit board and including electrically conductive pins, the input receptacle connector spatially aligned with a first one of the openings of the housing to allow the pins of the input receptacle connector to electrically connect to corresponding pins of a plug connector of an input signal line contained in the distribution duct so that a digital signal traveling along the input signal line is transmitted to the tap device;

an output receptacle connector connected to the circuit board and including electrically conductive pins, the output receptacle connector spatially aligned with a second one of the openings of the housing to allow the pins of the output receptacle connector to electrically connect to corresponding pins of a plug connector of an output signal line contained in the digital distribution duct, ones of the pins of the output receptacle connector being electrically connected to ones of the pins of the input receptacle connector to enable the digital signal to be transmitted from the input receptacle connector to the output receptacle connector; and

a tap output receptacle connector connected to the circuit board and including electrically conductive pins, the tap output receptacle connector spatially aligned with a third one of the openings of the housing to allow the pins of the tap output receptacle connector to electrically connect to corresponding pins of a plug connector of an external signal supply line that is electrically connected to one of the output devices, ones of the pins of the tap output receptacle connector being electrically connected to ones of the pins of the input receptacle connector to enable the digital signal to be transmitted from the input receptacle connector to the tap output receptacle connector, the input, output and tap output receptacle connectors being positioned relative to one another such that when the tap device is positioned inside the distribution duct and the input and output receptacle connectors are mated with the plugs of the input and



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output signal lines contained in the distribution duct, the tap output receptacle connector is spatially aligned with and faces one of the openings of the cover of the distribution duct to enable the plug connector of the signal supply line to be mated with the tap output receptacle connector.

2. The tap device of claim 1, in which the input receptacle connector and the output receptacle connector are in-line and face in opposite directions and the tap output receptacle connector is provided between the input and output receptacle connectors and faces in a direction transverse to the directions that the input and output receptacle connectors face to thereby provide a T-shape for the tap device.

3. A power and digital signal distribution duct configured to supply power and a digital signal to multiple output devices, comprising:

a U-shaped duct housing that includes first and second longitudinal compartments;

a cover attached to the duct housing, the cover including a first set of longitudinally spaced-apart openings that are arranged to be aligned with and run along the first longitudinal compartment and a second set of longitudinally spaced-apart openings that are arranged to be aligned with and run along the second longitudinal compartment;

a power line provided in the first longitudinal compartment, the power line being electrically connected to an external power source;

a power receptacle provided in the first longitudinal compartment and electrically connected to the power line, the power receptacle being spatially aligned with an opening of the first set of longitudinally spaced-apart openings to enable the power receptacle to mate with a power plug of an external power supply line connected to one of the output devices;

an input signal line provided in the second longitudinal compartment, the input signal line being electrically connected to an external digital signal source and including a plug connector having electrically conductive pins, the digital signal source configured to transmit a digital signal to the input signal line;

an output signal line provided in the second longitudinal compartment and including a plug connector having electrically conductive pins;

a high-definition multimedia interface tap device provided in the second longitudinal compartment and including:  
an input receptacle connector mated with the input signal line, the input receptacle connector including electrically conductive pins that are electrically connected to the pins of the plug connector of the input signal line to enable transmission of the digital signal from the input signal line to the tap device;

an output receptacle connector mated with the output signal line, the output receptacle connector including electrically conductive pins that are electrically connected to the pins of the plug connector of the output

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signal line, ones of the pins of the output receptacle connector being electrically connected to ones of the pins of the input receptacle connector to enable the digital signal to be transmitted from the input receptacle connector to the output receptacle connector and the output signal line; and

a tap output receptacle connector including pins that are electrically connected to ones of the pins of the input receptacle connector to enable the digital signal to be transmitted from the input receptacle connector to the tap output receptacle connector, the input, output, and tap output receptacle connectors being positioned relative to one another such that the input and output receptacle connectors face in longitudinal directions along the second longitudinal compartment of the duct housing and the tap output receptacle connector faces the cover and is aligned with one of the openings of the second set of longitudinally spaced-apart openings to thereby enable the tap output receptacle connector to be mated with a plug connector of an external signal supply line electrically connected to one of the output devices so that the digital signal is transmitted to the signal supply line and the output device.

4. The power and digital signal distribution duct of claim 3, further comprising a signal boosting device provided in the second longitudinal compartment and electrically connected to the input signal line, the signal boosting device operable to increase a signal level of the digital signal supplied to the tap device.

5. A high-definition multimedia interface system configured to supply a digital signal to multiple output devices, comprising:

multiple high-definition multimedia interface tap devices each including a tap output receptacle connector that has electrically conductive pins that are configured to connect to corresponding pins of a plug connector of a signal supply line connected to one of the output devices; and

multiple signal lines hard-wired to the high-definition multimedia interface tap devices to form a daisy chain in which the high-definition multimedia interface tap devices are electrically connected together to facilitate communication of the digital signal between the high-definition multimedia interface tap devices, each signal line serving as an output signal line for one of the multiple high-definition multimedia interface tap devices and as an input signal line for another one of the high-definition multimedia interface tap devices, and the high-definition multimedia interface tap devices including electrical connections between the signal lines and the tap output receptacle connectors to thereby facilitate communication of the digital signal to the output devices when the signal supply lines connected to the output devices are connected to the tap output receptacle connectors.

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